Office of Operating Experience Analysis, EH-33 • U.S. Department of Energy • Washington, D.C. 20585

OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

February 13 through February 19, 1998

Summary 98-07

Operating Experience Weekly Summary 98-07

February 13 through February 19, 1998

Table of Contents

Visit Our Web Site

The Weekly Summary is available, with word search capability, via the Internet at http://tis.eh.doe.gov/web/oeaf/oe_weekly/oe_weekly.html. If you have difficulty accessing the Weekly Summary at this URL, please contact the ES&H Information Center, 1-800-473-4375 for assistance. If you have additional pertinent information or identify inaccurate statements in the summary, please bring this to the attention of Jim Snell, 301-903-4094, or Internet address jim.snell@hq.doe.gov, so we may issue a correction.

EVENTS

1. IMPROPER RADIOLOGICAL WORK PRACTICES

On February 4, 1998, at the Los Alamos National Laboratory, a DOE facility representative observed a worker walking through an uncontrolled area after the worker alarmed a whole-body contamination monitor. The worker had been self-monitoring at the exit of a radiologically controlled area in the Chemistry and Metallurgy Research Facility when the alarm occurred. He walked through the uncontrolled area to contact a radiological control technician for assistance, then walked back into the controlled area. The worker should have remained in the area to prevent cross-contamination. Poor radiological work practices can result in the spread of contamination and unnecessary radiological exposures. (ORPS Report ALO-LA-LANL-CMR-1998-0007)

Investigators reported that the worker left the controlled area because there was no phone nearby to contact a radiological control technician. When the radiological control technician arrived, he told the worker he believed the alarm was caused by high background in the area of the monitor. The technician based this belief on the fact that a gamma-emitter source was being used in an adjacent room. The technician had the worker self-monitor while he placed his body between the worker and the room to shield the background radiation. The monitor alarmed again indicating 9,000 dpm beta, with no alpha activity, on the area of the worker's body that was not shielded by the technician. Because nearly all radioactive material used in the area emitted alpha radiation, the radiological control technician found this reading consistent with his belief that the alarm resulted from elevated background from the gamma source. The technician escorted the worker down a corridor away from the room with the source and performed a whole-body survey using a portable alpha-beta survey instrument. He detected no alpha activity and released the worker because he still believed the beta survey could not be performed properly because of elevated background radiation.

The DOE facility representative’s observation report listed the following radiological work practice concerns.

- When the worker walked through the uncontrolled area to find a radiological control technician he did not adhere to DOE/EH-256T, *Radiological Control Manual*, article 346.5, or the Laboratory Radiological Control Manual. These manuals require personnel to remain in the immediate area when a contamination monitor alarms and to take actions, such as putting a glove on a contaminated hand, that may minimize cross-contamination.

- The radiological control technician did not adhere to facility procedure ESH-01-09-05.3, "Responding to Personnel Contamination." Section 7.1.2.b of this procedure states: "All alarms may be actual contamination and must be treated as real until proven otherwise."

- The radiological control technician did not adequately consider the possibility that the beta activity measured by the monitor could be real contamination. He did not perform adequate surveys to positively confirm that the contamination was not real and did not have the worker don appropriate protective clothing when escorted out of the controlled area.

- Neither the worker nor the radiological control technician adhered to DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter II, section C.6, which states that operators should believe instrument readings and treat them as accurate until proven otherwise. Neither the worker nor the technician believed the second alarm on the monitor could be in response to real contamination. In addition, before the technician arrived, the worker believed the alarm was probably caused by radon. The worker and technician both doubted the reliability of the monitor.

- The facility representative also noted the following poor practices: (1) the worker chose to seek assistance by walking through the uncontrolled area rather than donning proper anti-contamination clothing (e.g., booties); (2) the worker did not inform the radiological control technician that he had walked through the uncontrolled area; and (3) neither the worker nor the technician informed another person walking in the immediate area of the potential for contamination.

On February 12, 1998, the facility manager held a meeting to discuss the issues raised by the DOE facility representative and determine corrective actions. Meeting attendees learned that the worker did not adhere to facility policy requiring personnel to contact Health Physics Operations personnel if contamination is detected when leaving a controlled area and to remain in the controlled area until cleared to leave. They also learned that Inorganic Elemental Analysis personnel moved the gamma source into the room without informing Health Physics Operations personnel, thus preventing them from performing surveys to determine if the source would interfere with the operation of the contamination monitor. The following corrective actions were taken.

- Health Physics Operations personnel attempted to adjust the monitor to counteract the background effects of the gamma source. However, they had to move it to a different location within the controlled area to counteract the background effects of the gamma source.

- The Health Physics Operations team leader counseled the radiological control technician on the correct response to alarms to prevent the spread of contamination.

- Facility managers discussed the importance of keeping Health Physics Operations personnel informed about the movement of the gamma source within the facility with Inorganic Elemental Analysis managers. In addition, Inorganic Elemental Analysis managers reviewed the handling procedures for the source to ensure that adequate radiological controls are in place.

OEAF engineers reviewed a similar event about improper radiological practices that occurred at the Oak Ridge National Laboratory on February 6, 1998, where a health physics technician failed to perform a post-job survey that would have identified contamination. Workers at the Instrument and Control Facility were removing floor tiles containing asbestos. As part of the safe work permit, a health physics supervisor instructed a health physics technician to perform a pre-job survey for radiological contamination, followed by a post-job survey. The technician conducted the pre-job survey and found no contamination, but he failed to perform the post-job survey. Five days later, the supervisor checked the work area and discovered that the post-job survey was not performed. He performed the survey and detected levels of fixed contamination up to 165,000 dpm/100 cm^2 beta-gamma. The supervisor posted the area as a fixed contamination area that required exit surveys. (ORPS Report ORO--ORNL-X10IANDC-1998-0001)

These events illustrate the importance of exercising sound radiological work practices. Radiological managers and supervisors should make frequent tours of the workplace to inspect the adequacy of radiological work practices and radiation work permits, as well as observance of protective clothing requirements. DOE/EH-256T, *Radiological Control Manual*, provides guidance for good radiological work practices. The radiological health and safety policy in the manual states: "Conduct radiological operations in a manner that controls the spread of radioactive materials and reduces exposure to the work force and the general public and that seeks exposure levels as low as reasonably achievable."

KEYWORDS: alarm, monitor, contamination, radiation monitoring, radiation survey

FUNCTIONAL AREAS: Radiation Protection

2. INADEQUATE REVIEW OF WORK DOCUMENTS FOR RADIOLOGICAL WORK

On February 4, 1998, at the Savannah River Analytical Laboratory, the facility manager reported management concerns regarding inadequate preparation and review of work documents that resulted in worker exposure to higher than expected contamination levels during decontamination and remediation activities. On January 22, 1998, radiological control technicians surveyed a laboratory following glovebox removal and discovered contamination levels up to 1,000,000 dpm alpha and 20,000 dpm beta-gamma from metal filing residue. They did not detect any airborne activity levels. Work planners did not anticipate activity levels of this magnitude from this work. The radiological control technicians immediately posted the laboratory as a high contamination area. Investigators determined that inadequate reviews of the work documents resulted in exposing the workers to the unexpected high contamination levels. The workers were not contaminated, but there was the potential for contamination and the spread of contamination. (ORPS Report SR--WSRC-ALABF-1998-0001)

Workers assigned to remove the glovebox cut through a stainless-steel vacuum line that contained legacy plutonium contamination. The metal filing residue from the cutting operation spread contamination in the work area. On February 4, facility managers identified a concern that there was inadequate preparation and review of work documents (i.e. work clearance permit, radiation work permits, and work packages) associated with the laboratory decontamination and remediation effort. The facility manager suspended work clearance permits pending a briefing on requirements of work document preparation and review.

NFS has reported numerous events in the Weekly Summary involving inadequate planning and review of work documentation. Following are examples.

- Weekly Summary 96-03 reported that four operators at the Savannah River F-Tank Farm were subjected to airborne contamination and received beta-gamma skin contamination while conducting an annual air pressure test on a transfer line jacket. A plug used to seal a drain line dislodged releasing dust and contamination. Investigators determined that there was an inadequate review of the evolution work package that had been modified since the last test. Also, the ALARA review did not include methods for minimizing exposure, containing contamination, or identifying potential sources of contamination.

- Weekly Summary 95-44 reported that a hydrogen flash fire occurred when a subcontractor at the Fernald Environmental Project cut a 1-inch metal pipe with a portable electric band saw during decontamination and demolition. The subcontractor was removing piping associated with an anhydrous hydrofluoric acid system that had been shut down since 1988. Heat generated by the saw caused a rapid exothermic reaction of gas that resulted in the fire. Investigators believed that, because the lines had been open to the atmosphere and the system had been shut down for years, the subcontractor assumed there would be no hydrogen. (ORPS Report OH-FN-FERM-FEMP-1995-0122)

- Weekly Summary 95-12 reported that a radiological control technician at the Los Alamos National Laboratory Firing Sites and High Explosives Laboratory discovered three subcontractors working in a contaminated soil area that contained depleted uranium. The workers did not receive notification of the hazards associated with the area where explosives containing depleted uranium were once detonated. Investigators determined that radiological control personnel did not perform an adequate review and did not address the presence of legacy contaminated soil at the work site. (ORPS Report ALO-LA-LANL-FIRNGHELAB-1995-0008)

These events underscore the importance of performing thorough reviews of work activities to identify radiological and safety hazards. These reviews should consider past operations at the facility. Because of these past operations and the fact that radiological operations may not have been conducted in a manner consistent with today's practices and requirements, it would not be unusual to find high contamination levels at the facility.

The cleanup, decommissioning, dismantling, remediation, or refurbishing of older buildings and laboratories can present unique circumstances of high contamination and radiation levels in unexpected locations that challenge the DOE radiological control policy of maintaining personal radiation exposure As-Low-As-Reasonably-Achievable (ALARA). Activities of this type may require extraordinary planning, coordination, and effort before actual execution of any work. DOE/EH-256T, *Radiological Control Manual*, part 1, "Planning Radiological Work," states that technical requirements for the conduct of work, including construction, modification, operation, maintenance, and decommissioning, shall incorporate radiological criteria to ensure safety and maintain radiation exposures ALARA. Maintenance and modification plans and procedures shall be reviewed to identify and incorporate radiological requirements, such as engineering controls and dose and contamination reduction considerations.

KEYWORDS: ALARA, contamination, radiation protection, work control, work planning

FUNCTIONAL AREAS: Radiation Protection, Work Planning

3. CONDUCT OF OPERATIONS REQUIREMENTS VIOLATION

On February 10, 1998, at the Idaho National Engineering and Environmental Laboratory Advanced Test Reactor, an electrician violated conduct of operations requirements by starting a gland seal water pump. This pump provides gland seal water to several primary reactor system components including seals on the main reactor coolant pump and reactor vessel penetrations. The electrician was investigating why the pump could not be started from the control room and started it using the local start button. Facility conduct of operations requirements state that plant equipment is to be operated only by certified plant operators. The plant foreman immediately notified operations personnel, who shut down the pump from the control room. There were no adverse effects to the environment, safety, or health and no system damage as a result of this event. (ORPS Report ID--LITC-ATR-1998-0002)

Following completion of routine preventive maintenance on the gland seal water pump, maintenance personnel requested operations personnel to start the pump from the control room to complete an operational checkout of the pump. The pump failed to start, so the shift supervisor directed the plant foreman to visually inspect local electrical interlocks at the pump. The plant foreman and a maintenance electrician entered the pump area and verified that the local stop/lockout button was not depressed. The electrician then pushed the local start button; however, his action violated conduct of operations requirements.

Investigators determined that the electrician was not instructed to operate any equipment as part of troubleshooting. The electrician told investigators that he pushed the start button because he believed that the plant foreman was attempting to start the pump locally.

NFS has reported on similar conduct of operations violations in several Weekly Summaries. Following are some examples.

- Weekly Summary 97-39 reported that subcontractor electricians at the Savannah River Site caused a power loss to an instrument panel when they opened an electrical disconnect without authorization. (ORPS Report SR--WSRC-HTANK-1997-0028)

- Weekly Summary 97-20 reported that a Fernald Environmental Management Project subcontract electrician was exposed to a 480-volt electrical shock hazard when he violated procedures. The facility manager determined that he connected wiring in a repaired conduit for parking lot lighting to a 480-volt source without authorization and outside his job scope. (ORPS Report OH-FN-FDF-FEMP-1997-0032)

- Weekly Summary 97-05 reported that at Hanford, a design engineer shut down the exhaust fans for a contaminated building to verify as-built schematic drawings without using an approved work package. (ORPS Report RL--BHI-DND-1997-0002)

- Weekly Summary 96-41 reported that fire department personnel at the Oak Ridge Y-12 site blocked a fire protection system master box without the knowledge or approval of the operations manager. A fire protection inspector blocked the box while connecting power to a fire system in a de-energized building. (ORPS Report ORO--LMES-Y12NUCLEAR-1996-0021)

OEAF engineers searched the ORPS database for occurrences where technicians were involved in conduct of operations violations and found 699 occurrences. More than half of the occurrences had a direct cause of personnel error. Approximately 40 percent of the personnel error problems resulted from inattention to detail, and approximately 45 percent resulted from a procedure that was not used or used incorrectly. Figure 3-1 shows the distribution of direct causes for technician conduct of operations violations.

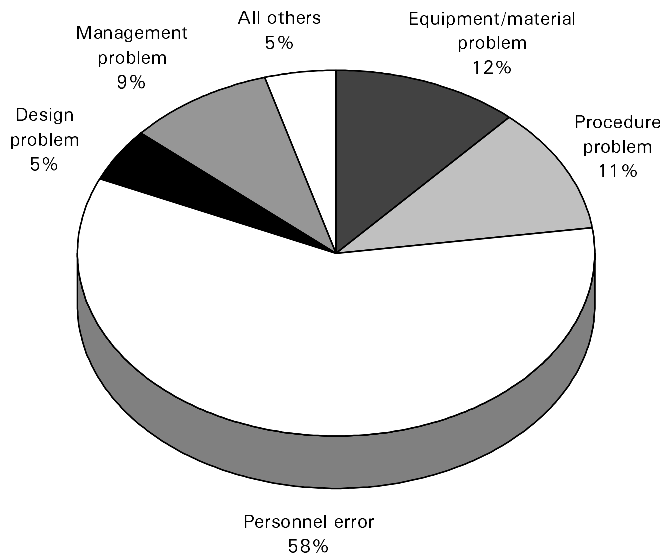

Figure 3-1. Direct Causes for Technician Conduct of Operations Violations[1]

These events illustrate the potential impact of violating conduct of operations requirements. Violating these requirements places personnel, equipment, and the environment at risk. These events also demonstrate the importance of clear, succinct communications between workers. DOE facility managers should review requirements and procedures to ensure that employees understand the requirements for control of the status of equipment.

- DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, states that DOE policy is to operate DOE facilities in a manner to assure an acceptable level of safety and to ensure procedures are in place to control conduct of operations. Chapter VIII, “Control of Equipment and System Status,” provides an overall perspective on control of equipment and system status.

- DOE 4330.4B, *Maintenance Management Program*, chapter 6, “Maintenance Procedures,” identifies maintenance procedures and other work-related documents needed to provide appropriate work direction and ensure that maintenance is performed safely and efficiently. Chapter 8, “Control of Maintenance Activities,” states that a work control program establishes the requirements for identifying, planning, approving, and conducting maintenance activities. The Order provides a definition of maintenance management and describes the types of work that should be controlled.

[1] OEAF engineers searched the ORPS database using the graphical user interface for reports with (“workers” and (“violated” or “failed to” or “did not”)) in the cause narrative and found 699 occurrences. Data was sampled to determine if occurrences involved conduct of operations violations. Sampling revealed an error of less than 2 percent for the personnel error slice.

- DOE-STD-1050-93, *Guide to Good Practices for Planning, Scheduling, and Coordination of Maintenance at DOE Nuclear Facilities*, provides information on work controls and work coordination.

- DOE-STD-1031-92, *Guide to Good Practices for Communications*, discusses the need for clear, formal, and disciplined communications and provides guides to improve communications.

KEYWORDS: conduct of operations, electrical maintenance, personnel error

FUNCTIONAL AREAS: Electrical Maintenance

4. MISSED SURVEILLANCES AT MOUND

On February 16, 1998, at the Mound Plant Tritium Facilities, facility workers determined that a data-logging computer for radiation monitoring systems had been off-line for 9 days, even though the operational controls (authorization basis) manual for the facility required daily surveillance of the computer. Facility workers immediately rebooted the computer and restored data-logging. The operability of the radiation monitoring system sensors and alarms was not compromised, and there were no impacts to the environment, safety, or health as a result of this event. (ORPS Report OH-MB-BWO-BWO01-1998-0003)

Investigators determined that the operational controls manual establishes the surveillance frequency for the data-logging computer. Site personnel updated this document and managers approved it for use on December 5, 1997. Verification of data-logging computer operability was not required in the previous revision of the manual, and facility managers failed to incorporate the new surveillance requirements into facility practices.

NFS has reported numerous events where surveillances were not performed at the required frequencies. Following are some examples.

- Weekly Summary 98-5 reported two events involving the failure to conduct surveillances and inspections on time. Facility personnel at the Hanford Tank Farm discovered that functional tests for the high-efficiency particulate air filter differential pressure interlocks and the stack high radiation alarm were not current. Investigators determined that no one entered facility safety documentation changes into the computerized planned maintenance system used to schedule surveillances. At the East Tennessee Technology Park (K-25 Site), fire protection personnel reviewing inspection and test records discovered that the database contained no inspection records for five building sections. Investigators determined that the computerized fire inspections management information system did not schedule several monthly fire department surveillances. (ORPS Reports RL--PHMC-TANKFARM-1998-0010 and ORO--LMES-K25GENLAN-1998-0003)

- Weekly Summary 94-13 reported that operators at the Idaho Irradiated Fissile Material Storage Facility discovered that atmospheric samples of certain dry wells were not performed every 2 years, as required by the technical standard. When the individual responsible for tracking the performance of the surveillance was transferred to another group, the remaining personnel forgot to perform the surveillance. As a corrective action, management personnel developed a site-wide computerized surveillance scheduling program. (ORPS Report ID--WINC-FUELRCSTR-1994-0007)

Proper performance of surveillances is important to ensure the availability and correct functioning of operational safety required systems. These events illustrate the importance of properly tracking, scheduling, and conducting surveillances. When facilities change their safety documentation, managers need to make sure that surveillance requirements in the new documentation are incorporated into facility practices. DOE contractors who operate nuclear facilities and fail to conduct required surveillances or implement corrective actions for identified deficiencies could be subjected to Price-Anderson civil penalties under the work processes and quality improvement provisions of 10 CFR 830.120, *Quality Assurance Requirements*. DOE facility managers should review their surveillance practices to ensure that scheduled frequencies are correct as specified in their safety documentation. DOE O 5480.22, *Technical Safety Requirements*, attachment 1, describes the purpose of surveillance requirements and states that each surveillance shall be performed within the specified interval.

KEYWORDS: surveillance, test, inspection, compliance

FUNCTIONAL AREAS: Surveillance

5. EXCESSIVE HYDROGEN LEVELS DETECTED

On February 12, 1998, at the Rocky Flats Environmental Technology Plutonium Processing and Handling Facility, the facility manager reported that gas analysis results of a suspect sample showed that it contained nitrous oxide with 22 percent free hydrogen. On February 9, the Liquids Removal Team was attempting to drain liquid into a bottle from a line between a tank and a glovebox in preparation for removing the system for building deactivation. They believed the system contained oxalic acid, which is clear and colorless. However, during the draining activities, they noticed an acidic odor and observed a orange-colored gas. The job supervisor notified the configuration control authority, who directed the supervisor to stop work and place the evolution in a safe configuration. Failure to adequately characterize the system contents before beginning work resulted in workers handling an unexpected hazardous chemical mixture that had a hydrogen content high enough to explode had a spark been present. (ORPS Report RFO--KHLL-771OPS-1998-0006)

Industrial hygienists responded to the event, performed air surveys of the area and the bottle, and detected nitric acid fumes in the bottle. The configuration control authority initially assigned a watch-stander to observe the bottle and its contents for any abnormalities. The facility manager later directed laboratory personnel to move the bottle to a glovebox and to sample and analyze its contents. Laboratory personnel completed the analysis and reported the results several days later.

The facility manager held a fact-finding meeting. Meeting attendees learned that facility personnel obtained and analyzed system samples to determine radioactivity content before the event. However, no one performed a chemical analysis because they believed that there was sufficient historical knowledge that indicated only oxalic acid was present in the system. Meeting attendees learned that the samples laboratory personnel analyzed that were taken after the event indicated that nitric acid and oxalic acid were present in the system. The facility manager directed facility personnel to conduct testing of the system to determine how the hydrogen was generated. He also directed that all breaches of or modification to process lines containing fissile and/or reagent materials must be administratively secured, including use of valve manipulations, and that any exemptions to this directive must be approved by the work authorization team lead. The configuration control authority directed personnel to place a "hydrogen potential caution" sign on the glovebox where the bottle is stored.

NFS has reported on numerous events in the Weekly Summary where hazards were not identified before beginning work on abandoned systems or facilities. Following are some examples.

- Weekly Summary 97-12 reported that facility personnel at Brookhaven National Laboratory reported that an abandoned sump located in a roadway near the Brookhaven Graphite Research Reactor contained standing water contaminated with 5,760 pCi/l gross beta, 340,000 pCi/l tritium, and 2,270 pCi/l strontium-90. The sump is part of the Graphite Research Reactor Complex, which was shut down in 1968. Laboratory personnel sampled the sump in 1991 and detected Sr-90, but failed to recognize the hazards associated with sample results. Investigators determined that when the reactor was shut down no one assumed responsibility or accountability for the sump and its contents. (ORPS Report CH-BH-BNL-BNL-1997-0012)

- Weekly Summary 97-10 reported that management and operations contractor personnel at the Mound Plant determined there was an unreviewed safety question because a room glovebox was not inerted as required by the final safety analysis report. A Tritium Operations operator discovered the discrepancy during a safety evaluation for a proposed repackaging operation to remove plutonium-239 parts contaminated with tritium stored in the glovebox. Investigators determined engineers did not conduct a safety analysis when they disconnected the inert gas system when process work in the building ceased. (ORPS Report OH-MB-EGGM-EGGMAT01-1997-0004)

- Weekly Summary 96-51 reported that managers at the Oak Ridge site, confirmed an unreviewed safety question for waste stored in a fissile material storage area. During a walk-through, licensing personnel found potentially hazardous, inadequately characterized, classified waste materials in a storage room. A hazards screening performed before the 1994 facility shutdown did not include the room or its contents. (ORPS Report ORO--LMES-Y12NUCLEAR-1996-0026)

Historically, DOE has required the use of numerous chemicals in a variety of missions. These range from common acids, bases, and oxidizing agents; to specialty organics, explosives, and hydrocarbon fuels; to toxic, corrosive, or flammable gases. In February 1994, the Secretary of Energy directed the Assistant Secretary of Environment, Safety and Health to undertake a comprehensive review of chemical safety practices and programs to identify chemical safety vulnerabilities confronting the DOE complex. The Assistant Secretary established a Chemical Safety Vulnerability Working Group to perform the review, taking into account the extent, diversity, and (all too often) uncharacterized condition of hazardous chemicals at many DOE facilities. The review was an integral part of the Department's overall strategy to increase the emphasis on safe and effective handling, use, and disposal of hazardous chemicals and to raise awareness about important issues related to chemical safety.

These events illustrate the importance of characterizing the contents of previously abandoned systems or equipment before work recommences. In order to safely accomplish this, personnel should perform hazards analyses and sample the system contents to determine both chemical and radiological contents. When removing systems or components that have not been used for years, past facility operations and missions should not be solely relied on because many materials can become unstable or unsafe over time and available documentation of the system usage may not be complete. It may become necessary for experienced personnel and subject matter experts to assist in these efforts from the outset. In this event, workers knowledge of what to expect allowed them to quickly report the unexpected results to the appropriate personnel. Facility managers quickly responded to the discrepancy and took actions. This combination of knowledgeable workers and responsive managers may have prevented a more serious event.

Chemicals found at facilities in shut-down, transition, or deactivation mode may present other hazards in addition to those typically found in active facilities. Chemicals remaining in shut-down vessels, piping systems, drums, or storage locations may be subject to long-term changes due to degradation or concentration, thereby increasing the associated hazards. OEAF engineers recommend that cognizant facility personnel assess the condition of chemicals subject to potential long-term storage, even though the safety of an active process has been analyzed and assured. Long-term changes could lead to spontaneous reactions such as corrosion-product catalyzed reactions, slow chemical degradation, concentration by evaporation, or inadvertent cross-contamination caused by system leaks or misrouting of transfers. OEAF engineers suggest that facility managers review existing vulnerability assessment corrective action plans, the issues associated with recent hazardous chemical events, and surveillance data to ensure they have a good understanding of their chemical inventories and can respond accordingly.

The following DOE and industry documents provide valuable guidance for all personnel who work with chemicals and hazardous materials.

- DOE-HDBK-1100-96, *Chemical Process Hazards Analysis,* February 1996, and DOE-HDBK-1101-96, *Process Safety Management for Highly Hazardous Chemicals,* February 1996, provide guidance for DOE contractors managing facilities and processes covered by the Occupational Safety and Health Administration (OSHA) Rule for Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119). Both handbooks are available on the Department of Energy Technical Standards Home Page at URL http://www.doe.gov/html/techstds/standard/standard.html.

- DOE Defense Programs Safety Information Letter, SIL 96-01, *Incidents from Chemical Reactions due to Lack of or Failure to Follow Proper Handling Procedures,* June 1996, provides guidance to prevent these incidents.

- DOE Defense Programs Safety Information Letter, SIL 96-05, *Compatibility Considerations in the Mixing of Waste Chemicals,* November 1996, addresses these issues and provides a guide to available information.

- OSHA Regulation 29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals,* contains the requirements for preventing or minimizing the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals. OSHA Regulation 29 CFR 1910.119 is available on the OSHA Home Page at URL http://www.osha-slc.gov/OshStd_data.

- National Research Council Publication ISBN 0-309-05229-7, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals,* 1995, provides guidance and recommendations regarding the safe handling and storage of chemicals, primarily in laboratory settings. However, the information can be adapted to other settings and situations. Information on how order this book can be obtained from the National Academy Press, 2101 Constitution Avenue, N.W., Washington, DC 20418. This book can also be ordered from most larger book stores.

KEYWORDS: chemicals, chemical safety, vulnerability studies

FUNCTIONAL AREAS: Chemistry, Industrial Safety, Materials Handling and Storage

FINAL REPORT

This section of the OE Weekly Summary discusses events filed as final reports in the ORPS. These events contain new or additional lessons learned that may be of interest to personnel within the DOE complex.

1. MOCK-UP USED TO SOLVE CRITICALITY ALARM SYSTEM EQUIPMENT PROBLEMS

On July 8, 1997, at the Savannah River Site, engineers began an investigation into spurious alarms associated with criticality alarm systems in the FB-Line and F-Canyon facilities. The spurious alarms affected the Nuclear Incident Monitor (NIM) Model III digital units that replaced the NIM Model II analog units. To meet facility operational requirements, technicians removed the Model III units and reinstalled the Model II units. Equipment and Engineered Services personnel set up a mock-up of the FB-Line Model III NIM system at the Savannah River Technology Center. They tested the mock-up to determine the nature of the spurious alarms and discovered that the NIM instruments were susceptible to noise conducted through the interface cables. Previous stand-alone testing of the Model III NIM units did not identify the problems observed in the system mock-up, thus showing the value of using mock-ups in troubleshooting systems. (ORPS Reports SR--WSRC-FBLINE-1997-0026, SR--WSRC-FBLINE-1997-0028, and SR--WSRC-FCAN-1997-0039)

The criticality alarm system NIM unit, Model III, was an equipment improvement initiative that began in the late 1980s. The Model III NIMs used digital technology, in contrast to the analog/relay technology of the Model II NIMs, which are being replaced. Following the spurious alarms, Equipment and Engineered Services personnel mocked-up a Model III NIM that was electrically identical to the FB-Line system. The mock-up included 12 pairs of units, relays, electronics, and cabling. Engineers used a simulated control display panel in a controlled configuration as a source of radiated energy to test the NIMs for spurious false alarms. They identified an external annunciator relay that was generating noise in the 18-MHz range into the instrument via the mutual interface cables. They also determined that an electrostatic discharge gun provided a higher energy source of noise, at similar frequencies, allowing them to perform statistically significant tests. Engineers also conducted field walk-downs of the facility to identify any unique characteristics in the facility that could have contributed to the alarms. They identified four areas early in the troubleshooting as potential problems: (1) use of an external relay in the interface adapter cable to accommodate the facility alarm logic; (2) potential ground loops on the DC ground; (3) poor quality AC power; and (4) conditions related to the bypass operation itself.

A design analysis indicated that the instrument is susceptible to noise below 40 MHz, which is conducted into the instrument through the interface cables. This susceptibility is due to the lack of filtering of the instrument inputs and the logic speed. This phenomena had never been exhibited in the Model II NIMs because the comparator in the Model II unit directly drives a relay, which actuates the alarm circuits, and the relay has an inherent latency of approximately 25 milliseconds. This latency generally masks the noise in the frequencies of interest. Engineers did not identify susceptibility to frequencies under 40 MHz during the initial design of the Model III NIMs because the instruments were tested as stand-alone units. As stand-alone units the instruments were well protected against radiated energy; but when connected to external cabling, the instrument was open to unwanted noise conducted through the external wiring into the instrument.

Investigators determined that a design problem (inadequate or defective design) was both the direct and root cause of the occurrence. Corrective actions to address the direct and the root cause of this occurrence included the following.

- removal of the Model III NIMs and reinstallation of the Model II units
- a design review of the Model III NIMs and the proposed design modifications

The lessons learned from this occurrence highlight the difficulty inherent in the design of equipment using new technologies, in that the parameters of concern change as technologies change.

This occurrence illustrates the benefits of using system mock-ups for component and system testing. Although system mock-ups can be expensive, the information learned through their use can be invaluable in determining how components can be expected to perform when integrated as a system in the field. Mock-ups have been used for training, event reconstruction, and testing. NFS reported in Weekly Summary 92-34 that engineers at the Advanced Test Reactor in Idaho used a fuel mock-up for test simulations to determine how a fuel element was damaged during testing at the Hydraulic Test Facility. (ORPS Report ID--EGG-TRA-1992-0022) Mock-ups, simulations, modeling, and computer-aided design are tools that can help the designer ensure that equipment will fit where intended, personnel can operate it easily, and it will perform as expected.

KEYWORDS: criticality alarm, design, instrumentation, test

FUNCTIONAL AREAS: Design, Nuclear/Criticality Safety, Instrumentation and Control